Effect of priming on the germination of *Peltophorum dubium* seeds under water stress

ZHANG Wan-li[1], LI Le-ihong[2], ZU Yuan-gang[2], Sonia Perez[3]
[1] *East China Normal University, Shanghai 200062, P. R. China*
[2] *Northeast Forestry University, Harbin 150040. P. R. China*
[3] *Federal University of Sao Carlos, Sao Carlos 13565-905, Brazil*

Abstract: *Peltophorum dubium* seeds provided by Anhembi, SP were scarified in 98% H_2SO_4 for 15 min to overcome mechanical dormancy. Seeds were primed in solutions of 0.2% Captan at 10 °C and 27°C, PEG 6000 −1.0 MPa at 10°C and 27°C, 0.5 mol KNO_3, 0.75 Mol KNO_3, 1.0 Mol KNO_3. Eight treatments including the primed seeds and nonprimed seeds, five replicates with 100 seeds for each treatment, were set to 15-cm-Petri dish with double filter paper moistened with testing solution PEG in refrigerator at 27°C. For the experiments of all the groups, osmotic potential were 0.0, −0.2, −0.4, −0.6, −0.8, −1.0, −1.2, and −1.4 MPa. *P. dubium* seeds were also set to water stress experiment in rolled paper with PEG solutions from 0.0 to −1.0 M Pa. Germination percentage decreased with the increase of PEG concentration. Control group had a better germination percentage than other groups. Germination hardly occurred in PEG −1.4 MPa.

Key words: Priming; Osmotic potential; Germination; Seeds, *Peltophorum dubium*
CLC number: S721.13 **Document code**: A **Article ID**: 1007-662X(2004)04-0287-04

Introduction

Seeds sown in the field may be unexpectedly exposed to numerous environmental hazards during germination and emergence. Moreover, the young seedlings may also be subjected to the detrimental effects of drought and cold weather. Temperature and moisture levels appear to be critical (Haridi 1985).

Water stress can reduce both the rate and percentage of germination. The range of response among species is wide, from the very sensitive (e.g., soybean) to the resistant (e.g., pearl millet). Resistant seeds may have an ecological advantage in that they can establish plants in areas in which drought-sensitive seeds cannot do so (Bewley & Black 1986).

Control of seeds water content by osmotic solutions or other methods can be used to prevent seeds from initiating radicle emergence and becoming susceptible to injury. Primed seeds can be dehydrated, stored and when rehydrated, they will germinate more rapidly and completely than these untreated seeds, particularly under stress conditions. Data from several studies indicated that seed priming shortens the time to germinate without lowering the potential that promote the radicle growth, that is, the primed seeds germinated faster but are not able to germinate at the water potential significantly lower than that control seeds could. The situation could be different however, under stressful conditions (Khan 1992).

Seed priming (osmoconditioning) has been used to improve vegetable and ornamental seeds performance by increasing the speed of germination as well as improving germination seed uniformity (Bradford 1986; Yoon *et al* 1997). Priming can also help seeds overcome environmental stresses such as germination under extremely high temperatures or salt and water stress (Atheron and Farooque, 1983; Cantliffe 1981; Yoon *et al.* 1997).

In bedding plants, primed seeds in PEG 6000 solutions had significantly higher germination rates at supraoptimal temperatures than non-primed seeds (Carpenter 1990)

Ornamental seeds primed with salt solution had significantly higher germination at a high temperature than control seeds and seeds primed in PEG 8000 solutions. Seeds respiration during germination of seeds primed with salt was higher than for control seeds or those primed with PEG. Primed seed with salt solution also was effective in increasing seedling emergence and for reducing the time of emergence in summer greenhouse studies (Yoon *et al.* 1997). Although priming has been used for many years to improve vegetable seed germination, little work has been reported on native species (Cordeiro & Di Stefano 1991; Cordoba *et al.* 1995).

The water potential of a dry seed is normally not more than −1.0 MPa, which is lower than the water potential of surrounding environment. It would be difficult for the seeds to germinate with water potential under −1.0 MPa.

Our work is to show the germination of primed and nonprimed *P. dubium* seeds under water stress in solutions of PEG 6000 from osmotic potential 0.0 to −1.4Mpa. The aim

Foundation item: This work is Supported by CAPES, Brazil. Open research laboratory of forest plant ecology, NEFU. The State's tenth five-year "211 Project"-supported key academic discipline program of ECNU。
Biography: ZHANG Wan-li (1971-), Associate professor, East China Normal University, Shanghai 200062, P. R. China Received date: 2004-09-29 (E-mail: wanlizhg@yahoo.com)
Received date: 2004-09-29
Responsible editor: Chai Ruihai

of this part experiment is to compare the germinability of primed seeds and nonprimed seeds under adverse conditions in the incubator and field. We try to find a group of seeds which are resistant to water stress in PEG solutions.

Materials and methods

Peltophorum dubium were provided by Anhembi, SP. All the testing seeds were scarified in 98% solution H_2SO_4 for 15 min to break dormancy. Seeds were primed in 0.2% captan for 10 h at temperature of 10°C, 4 h at 27°C, 24 h for PEG 6000 –1.0 MPa at 10°C and 27°C. Priming time was 10 h in solutions 0.5 mol KNO_3, 0.75 mol KNO_3, 1.0 mol KNO_3 at 27°C. All the seeds were kept in the refrigerator at 5(±)°C during the experiment. Concentrations of testing PEG solution were prepared at 0.0, –0.2, –0.4, –0.6, –0.8, –1.0, –1.2, and –1.4 MPa at 27°C according to F. A. Villela's osmotic potential table. Eight groups of seeds were designed for the test: control group, primed in captan 10 °C, captan 27 °C, PEG 10°C, PEG 27 °C, 0.5 mol KNO_3, 0.75 mol KNO_3, 1.0 mol KNO_3. For each group, five replicates were conducted with 100 seeds incubated in 15-cm-diameter Petri dish covered with double filter paper moistened by testing PEG solutions. Petri dishes with filter paper were sterilized 2 h at 150°C to minimize seed contamination. Daily observation of seeds germination was carried out, and fungi on the seeds were cleaned with 0.2% solution captan at any time when they appeared. Filter paper was changed when its color turned to yellow. Germinated seeds with 2 mm long radicles were removed out of the Petri dish. Tests finished with the germination of all the seeds or when the seeds no longer were able to germinate.

Seeds primed in water at 27°C for 10 h and none primed seeds were set to water stress experiment in rolled paper moistened with PEF solutions of 0.0, –0.2, –0.4, –0.6, –0.8, –1.0, –1.2 MPa.

For each treatment there were 4 replicates with 20 seeds in each replicate. Daily observation was recorded on seeds germination, clarening fungi from seeds and seedlings when it is necessary. After 2 weeks, all seedlings in each replicate were dried for dry matterrs of cotyledon, stem and root three parts. Lengthes of stem and root were noted down before drying.

Seeds primed in KNO_3 solutions and nonprimed seeds were planted in the experimental garden in June. Daily observation on seedlings was conducted. Five weeks later the seedlings were cut for analysis

Final germination percentages were collected to analyze the germination of different groups under water stress in PEG solutions.

Results and data were analyzed using Test F.

Results and discussion

Seeds germination percentage decreases with the increase of osmotic potential, and normally the higher the potential is, the lower the percentage is. For *P. dubium*, an appropriate potential helps the germination percentage when the potential is below –0.4 MPa, after this potential the percentage decreases sharply. No germination occurred when potential was below –1.2 Mpa. Seeds primed in captan 10°C and captan 27 °C had the highest germination percentages at–0.2 MPa. The highest germination percentage for seeds primed in captan PEG 10°C occurred at –0.4 MPa, while the highest percentage for seeds primed in PEG 27°C was at 0.0 MPa. Control group had the highest germination percentage at –0.4 MPa. (Fig. 1)

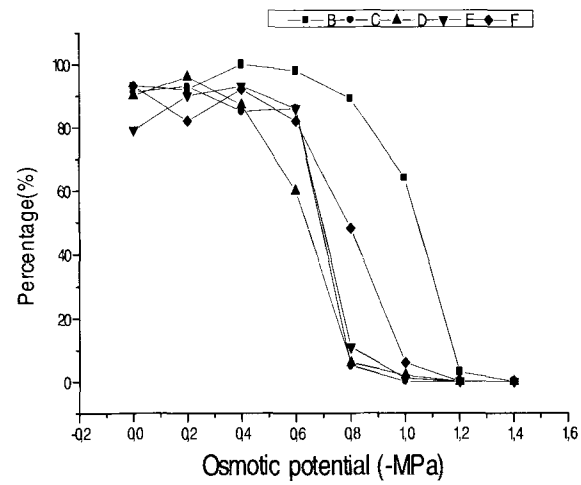

Fig. 1 Germination percentage of *P. dubium* seeds of five treatments (B--control; C-- captan 10°C; D-- captan 27°C; E--PEG 10°C; F--PEG 27°C) in osmotic potential of solution PEG 6000.

All the groups had a trend to decrease with the increase of PEG concentration. Few seeds germinated at –1.2 MPa, no seed germinated at –1.4 MPa. Control group had a higher germination percentage than any other group from –0.4 to–1.2 MPa. Only at –0.2 MPa did the seeds primed in captan 10°C and captan 27°C have higher germination percentages than those in control groups.

The highest germination percentages of seeds for 0.5 mol KNO_3 group, 0.75 mol KNO_3 group, and 1.0 mol KNO_3 group occurred at –0.2 MPa, –0.4 MPa, –0.6 MPa, respectively. Only seeds in control group and primed in 0.75 mol KNO_3 group had 3% germination in PEG at –1.2 MPa. Other groups had no germination at this high concentration. There was no germination for seeds treated in PEG solution at –1.4 MPa (Figure 2). The experiment lasted 35 days, after then no more seed had the possibility to germinate.

From Figure 2, we can see that the seeds in control group had the highest germination percentage and the above ground biomass of individual was also the highest in the field performance. Seeds primed in 0.75 mol KNO_3 also had the lowest above ground biomass. The germination percentage in 1.0 mol KNO_3 was higher than that in 0.75 mol KNO_3 and 0.5 mol KNO_3, while germination percent-

age in 0.5 mol KNO_3 was the lowest.

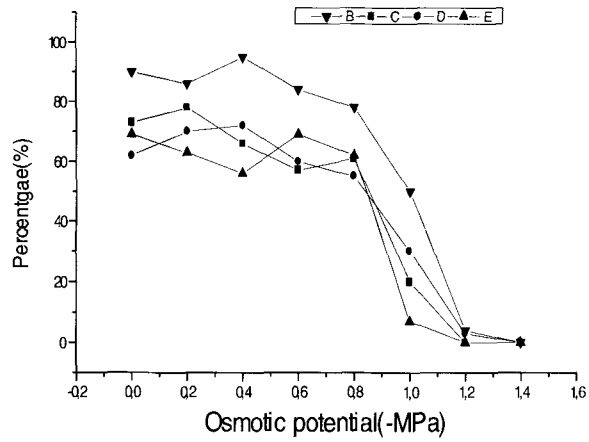

Fig. 2. Germination percentage of *P. dubium* seeds of four treatments (B--control; C--primed in K^+ 0.5; D--primed in K^+ 0.75; E--primed in K^+1.0) in osmotic potential of solution PEG 6000

There was no significant difference in germination percentage between nonprimed seeds and primed seeds in PEG solution with osmotic potencial above –0.6 Mpa (Table 1). Nonprimed seeds had significant higher germination percentage than the seeds primed with captan in PEG solution below –0.6 Mpa. The germination percentage for seeds primed in PEG was significant lower than that of nonprimed seeds.

Table 1. Mean germination percentage(arcsin) for *P. dubium* seeds of control group and primed groups.

Treatment (-MPa)	Germination Percentage/%		Treatment	Percentage	
control-0.0	80.31	AB	control-0.0	80.31	A
control-0.2	77.555	AB	control-0.2	77.555	A
control-0.4	90	A	control-0.4	90	A
control-0.6	86.77	AB	control-0.6	86.77	A
control-0.8	76.8975	AB	control-0.8	76.8975	A
captan10-0.0	74.325	AB	peg10-0.0	80.31	A
captan10-0.2	75.7025	AB	peg10-0.2	69.39	AB
captan10-0.4	68.3	BC	peg10-0.4	81.0725	A
captan10-0.6	69.8225	B	peg10-0.6	71.2	A
captan10-0.8	17.855	D	peg10-0.8	18.98	C
captan27-0.0	76.465	AB	peg27-0.0	73.235	A
captan27-0.2	80.31	AB	peg27-0.2	70.055	AB
captan27-0.4	70.7675	B	peg27-0.4	83.54	A
captan27-0.6	52.25	C	peg27-0.6	70.4475	AB
captan27-0.8	13.535	D	peg27-0.8	48.7975	B
	Δ=16.44			Δ=22.01	
	F=49.22			F=16.42	
	Fc=2.15			Fc=2.15	

* The numer after the groups means the osmotic potential of PEG solutions.

From Table 2, the seeds primed in KNO_3 had significantly lower germination percentage than nonprimed seeds. Field performance showed that seeds primed in captan 10 °C had a significant lower germination percentage than nonprimed seeds. No significant difference in germination was found between nonprimed seeds and seeds primed in captan 27°C, PEG 10 º and 27 °C, KNO_3 0.5, 0.75 and 1.0 mol (see Table 3).

Table 2. Mean germination percentage(arcsin) for *P. dubium* seeds of control group and primed in KNO_3 solutions groups.

Treatment (-MPa)	Germination percentage (%)	
control-0.0	74.6125	AB
control-0.2	69.39	AB
control-0.4	77.08	A
control-0.6	67.355	AB
control-0.8	62.5725	B
0.5 K-0.0	60.1975	BC
0.5 K-0.2	65.465	AB
0.5 K-0.4	56.4	BC
0.5 K-0.6	50.825	BC
0.5 K-0.8	53.43	BC
0.75 K-0.0	54.495	BC
0.75 K-0.2	60.235	BC
0.75 K-0.4	60.055	BC
0.75 K-0.6	53.21	BC
0.75 K-0.8	49.3425	C
1.0 K-0.0	58.955	BC
1.0 K-0.2	53.8175	BC
1.0 K-0.4	49.39	C
1.0 K-0.6	57.685	BC
1.0 K-0.8	53.015	BC
	Δ=13.18	
	F=10.09	
	Fc=1.96	

* The numer after the groups means the osmotic potential of PEG solutions.

Table 3. Mean germination percentage(arcsin) for *P. dubium* seeds of control group and primed groups of field performance.

Treatment	Percentage	
Control-1	82,1625	A
captan10	67,21	B
captan27	69,39	AB
PEG 10	70,48	AB
PEG 27	78,9325	AB
control-2	55,26	BC
0,5 KNO3	41,3275	C
0,75 KNO3	38,49	C
1,0 KNO3	29	C
	Δ=14.85	
	F=37.24	
	Fc=2.71	

Germination percenages of nonprimed seeds and seeds primed in water had no significant difference. There was

also no significant difference in germination for primed seeds and nonprimed seeds in osmotic potential at 0.0, –0.2, –0.4, –0.6, and –0.8 Mpa. No seed germinated in PEG solution below –0.8 Mpa.

Ratio of root/stem decreased from 0.0 to –0.6 Mpa for seedlings of nonprimed seeds. This value increased at –0.8 Mpa , but lower than that at 0.0 Mpa. For seeds primed in water, the ratio of root/stem of seedlings had a trend to increase from 0.0 to –0.8 Mpa. Dry matter of seedlings of monrimed seeds had a trend to decrease, from 0.0 to –0.8 Mpa. But no significant difference was found among them (see Table 3).

Conclusion

Peltophorum dubium is an orthodox species and resistant to water stress. It was possible to have a very high germination percentage under water stress at –0.8 MPa in PEG solution. Water stress had almost no impact on its germination with the concentration that is not lower than –0.6 MPa. Seeds primed in 0.2% captan and–1.0 MPa PEG solutions at 10°C and 27°C had a significant decrease of germination under water stress at–0.8 MPa. Seeds primed in solution KNO_3 had also a significant decrease in germination percentage under water stress at –1.0 MPa. It is hard for *P. dubium* seeds to germinate at –1.2 MPa and impossible to germinate at –1.4 MPa at either 10°C or 27°C.

References

Atherton, J.G. & Farooque, A.M. 1983. High temperature and germination in spinach: II. Effects of osmotic priming [J]. Scientia Hort., **19**: 221-227.

Bewley, J.D. & Black, M. 1986. Seeds: Physiology of development and germination [M]. New York and London: Plenum Press, pp.231-233.

Bradford, K.J. 1986. Manipulation of seed water relations via osmotic priming improve germination under stress conditions. Proc. Seed germination Under Environ. Stress [J]. Hort Science. **2**: 1105-1112.

Cantliffe, D.J. 1981. Priming of lettuce seed of early and uniform emergence under conditions of environmental stress [J]. Acta Hort., **122**: 29-38.

Carpenter, W.J. 1990. Priming dusty miller seeds: Role of aeration, temperature, and relative humidity [J]. Hort Science, **25**: 299-302.

Cordeiro, S.R. & Di Stefano, G.J.L. 1991. Efeito del estrés osmótico sobre la germinaçao de semillas de *Tecoma stans* (Bignoniaceae.) [J] Ver. Bras. Sem., **39:** 107-110.

Cordoba, G.A.T., *et al.* 1995. Osmocondiçionamentos, secagem e armazenamento de *Eucalyptus citriodora*. Hook e *Eucalyptus grandis* W. Hill [J]. Rev. Bras. Sem.,**17**: 81-95.

Haridi, M.B. 1985. Effect of osmotic priming with polyethylene glycol on germination of Pinus elliottii seeds [J]. Seed Sci. & Technol., **13**: 669-674.

Khan, A.A. 1992. Preplant physiological seeds conditioning. Horticultural Review, **14**: 131-181.

Yoon, B.Y., Lang, H.J., Cobb, B.G. 1997. Priming with salt solutions improves germination of pansy seed at high temperatures [J]. Hort Science, **32**(2): 248-250.